

MOORE (W. O.)

LECTURE ON VISION
AND ITS DEFECTS.

BY

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LECTURE ON VISION AND ITS DEFECTS.

BY W. OLIVER MOORE, M. D., NEW YORK.

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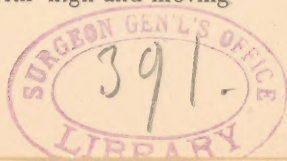
EYE LANGUAGE.

Of Nature's minute wonders, the human eye is the paragon. But it is not the apparatus which the delicate knife of the anatomist reveals, the retina and lenses, or even their combined arrangement, that most strikingly indicates the subtle workmanship involved in the little fleshy globule we call the eye: it is the effects they produce, the purposes they subserve, the results they accomplish. Far greater are these than the careless crowd dream of, or the imaginative fully realize. The phenomenon of sight is indeed sufficiently extraordinary, not less so are the minor missions which the visual organ fulfills. The eye speaks with an eloquence and a truthfulness surpassing speech. It is the window out of which the winged thoughts often fly unwittingly. It is the tiny magic mirror on whose crystal surface the moods of feeling fitfully play, like the sunlight and shadow on a stream.

Even in animals it is emphatically the expressive feature. Who has not noted the look of timid fondness with which a recreant dog approaches his master, or observed the gleam of woe with which the dying deer regards his hunters, and has not felt this? How aptly has the eye been called the "window of the soul." Instinctively it is raised in devotion, and bent downward in shame; when enthusiasm lends fire to the soul, the eye flashes; when pleasure stirs the heart, the eye sparkles; when deep sorrow darkens the bosom, the eye distils hot tears; when confidence stays the mind, the eye looks forth proudly; when love fills the heart, the eye beams with glad sympathy; when insanity desolates the brain, the eye roves wildly; and

"O'er the eye Death most exerts his might,
And hurls the spirit from her throne of light."

Thus through all the epochs of human experience, the eye typifies the workings of the soul. To an adept in eye language, traveling through the world is a delightful and constant resource, for if he perchance but catch the "bonnie blue e'en" of the passing peasant-girl a cheerful humor is induced which abides with him for hours. And the momentary beaming of a pair of dark lustrous orbs fills him with high and moving



thoughts. A modern writer, in order to illustrate an almost indescribable sentiment, says : " It was like the eye of a woman, first loved, to the soul of the poet." The power of the eye to quell and awe is well known. An infuriated animal has often been kept trembling at bay by the steadfast gaze of man, beneath which its own angry eye quailed, yet could not turn aside. How intuitively does the child understand the slightest expression of its mother's eye. In the pictures of the old masters the effect of the whole picture is often centered in the expression of this single organ. Who has not sometimes imagined a portrait animated with life ? Cover the eye, and the fantasy is gone. It has been remarked of Titian's portraits that they looked at us, more than we at them. Correggio excelled in painting downcast eyes ; Allston was remarkable for his gray, intellectual eyes ; Raphael in his St. Cæcilia presents the best example of the upturned eyes of inspiration. The unfortunate know a friend and are reassured, the timid recognize a master spirit and are strengthened, the guilty know their accuser and quail. Beware of the man whose eye you can never meet.

Richly expressive as is the human eye generally, we often see in men of profound sentiment, not infrequently, an aspect of indifference, because common life awakens not their spirits. We are told of Coleridge that, in moments of intense abstraction, his eyes were so void of expression as to appear almost senseless ; yet, in an expressive mood, they were proverbially eloquent. It is said of Schiller : " His deportment, his gait, the mould of his limbs, his least motion, was dignified and grand, *only his eyes were soft.*" The poet Gleim says of Frederick the Great : " His large eyes dart the most piercing look, but tempered with clemency." We can all probably recall the appearance of the eye when some gifted man, under some strong inspiration, has uttered a memorable thought ; or remember one, near and dear, who has breathed words, of deep interest into our ear. Shakespeare's pages are richly illustrated with this language of the eye ; hear Lear's adjuration to the unfortunate Gloucester :

" Get thee glass eyes ;
And like a scurvy politician, seem
To see the things thou dost not."

Othello, when first awakened to jealousy, in order to satisfy his doubts, exclaims to Desdemona : " Let me see your eyes." Alas that he did not credit their truthful expression ! In the awful hints the Ghost gives Hamlet of " that undiscovered country," among the effects prophesied from a more full revelation is to make his " eyes like stars start from their spheres." Iachimo, in his soliloquy over the sleeping Imogen, says :

“ The flame of the taper
Bows towards her ; and would underpeep her lids
To see the enclosed lights, now canopied
Under these windows : white and azure, lac'd
With blue of heaven's own tinct.”

Romeo, in Capulet's garden, is heard to say :

“ She speaks, yet she says nothing ; what of that ?
Her eye discourses ; I will answer it.”

And Juliet, warning him, says :

“ Alack, there lies more peril in thine eye
Than twenty of their swords ; look thou but sweet,
And I am proof against their enmity.”

In “ Love's Labour Lost,” Shakespeare declares :

“ From woman's eyes this doctrine I derive :
They are the ground, the books, the academies,
From whence doth spring the true Promethean fire.

* * * * *

For where is any author in the world
Teaches such beauty as a woman's eye ?”

Even the incorrigible Benedick says to Beatrice :

“ I will be buried in thy eyes.”

And Phoebe declares of Rosalind :

“ Faster than his tongue
Did make offence, his eye did heal it up.”

Much more might be added, but let this suffice. There can be no doubt but that the skill of the sculptor lies in giving the peculiar character to the eye of the bust under his hand : the proper expression once caught gives, even to the cold and colorless marble, a life-like appearance. Emerson, in his “ Conduct of Life,” speaking of American eyes in particular, says : “ Eyes are bold as lions, roving, running, leaping here and there, far and near. They speak all languages, they wait no introduction, they are no Englishmen ; the communication by the eye is, in the greater part, not subject to the control of the will. It is the bodily symbol of identity of nature. We look into the eyes to know if this other form is another self ; and the eye will not lie, but make a faithful confession what inhabitant is there. The revelations are some-

times terrific. The confession of a low, usurping devil is there made ; and the observer shall seem to feel the stirring of owls and bats, and horned hoofs, where he looked for innocence and simplicity." Solomon warns us against familiarity with "him that hath an evil eye ; for as he thinketh in his heart so is he." Vain and forgotten are all the fine offers and offices of hospitality, if there is no holiday in the eye, says Emerson.

The flowers and the stars speak a moving language, but from the eye beams what will endure when fragrance and light are no more. What are these compared with the more subtle signs which beam in the visual organs, the breathings of the soul, in that

" Bright ball on which the spirit sat
Through life, and looked out in its various moods
Of gentleness, and joy, and love, and hope,
And gained this frail flesh credit in the world."

EXPRESSION.

That the eye gives a certain expression is true in a very limited degree, and we must admit that a great part of the expression, good or bad, is due to changes taking place in the adjacent parts. The size of the orbit, the situation of the eyeballs, a man's being fat or thin will affect the expression of the eye. Let the hearer think for a moment of the immense difference in point of expression between a sunken and a prominent eye, and remember at the same time that the eyeball itself may be the same in both cases ; he will then understand the influence of surrounding circumstances on the appearance of the eye. The shape of the eye opening, the direction taken by it, the depth of the upper lid, the very manner in which the eyelashes grow, all these things, but perhaps more than all, that most important feature, the eyebrow, are powerful in affecting the expression of the eye.

We have all noticed the slight alterations which are transient and momentary, and which pass over the countenance as swiftly as the shadow of a summer cloud will cross a sunlit meadow. The quivering contraction of a moment's irritability, the quick perception of a joke, the little half-developed thought of suspicion crossing the mind, the kindling of a generous impulse or of a swift surprise—all things affect more or less this expression machinery and set it all in motion. The eye itself moves swiftly and suddenly as each different feeling asserts itself in the face, and by such movement—movement, not change—helps to enforce the expression of the moment. This is a point to mark, the eye moves, but the surroundings of the eye change. To illustrate this by fact. In France they play at a game where certain of the company are concealed, with the exception of their eyes ; it is the business of the rest of the

company to identify the concealed person simply by their eyes. Identification is extremely difficult, and I know a man who was unable to pick out his own wife when thus concealed. It happened once that a lady, celebrated for the beauty of her eyes, was drawn into this pastime, there being only one other person hidden beside herself and that an old gentleman not celebrated for his eyes. The pair were duly concealed and bandaged up with nothing but the eyes visible, and then a lady who was to declare to whom the respective eyes belonged was introduced. Without a moment's hesitation she walked straight to the eyes of the old man, exclaiming: "There is none but Madame B. can have such eyes as these!" The eye most certainly not only sees, that is, receives impressions passively on the retina, but it also looks reproachfully, looks angrily, looks lovingly; but how far such looks belong to the eye itself, or how far they may be influenced by the external phenomena we have been examining, it is impossible to say with certainty.

In the composer Haydn's mind there was a recognition of quality of hue to quality of sound. According to Haydn the trombone is deep red, the trumpet scarlet, the clarinet orange, the oboe yellow, the bassoon deep yellow, the flute sky blue, the diapason deep blue, the double diapason purple, the horn violet, the violin pink, the viola rose, the violincello red, the double bass crimson. This may appear to some as theoretical or fanciful, but if we turn to a passage of Haydn's works we will find that the theory holds. Let us examine the sunrise in the "Creation." At the commencement our attention is attracted by a soft streaming sound from the violins, scarcely audible, till the pink rays of the second violin diverge into the chord of the second; to which is gradually imparted a greater fullness of color as the rose violas and red violoncellos steal in with expanding beauty, while the azure of the flute tempers the mounting rays of the violin. As the notes continue ascending to the highest point of brightness the orange of the clarinet, the scarlet of the trumpet, the purple of the double diapason unite in increasing splendor till the sun appears at length in all the effulgence of harmony. As in music so in painting, we see illustrated the various shades of coloring going to make up mental impressions, each differing in their form of expressions according to the author of their being.

EYE PHENOMENA AND THEIR ILLUSIONS.

If the human eye is wonderful in its structure and in its visual powers, it is not less wonderful when we study the ordinary and abnormal phenomena which it presents to us. If pressure is made on the eyeball by the finger in a dark room, we shall see a brilliant spot of light on the side of the eye opposite to the point of pressure. If this experiment be made in the daylight the luminous spot will be surrounded with a broad black ring, and this ring by another ring of light.

Sir Isaac Newton describes the effect of pressure between the eyeball and nose "as a circle of colors like those on the feather from a peacock's tail," the colors vanishing in a minute if the eye and the finger remain quiet, but reappearing if the finger be moved with a quivering motion. The light thus produced by pressure is exhibited on various occasions. A blow on the eye or head propagated to the retina makes a flash of light shoot from the eyeball. In the act of sneezing, gleams of light are emitted from each eye, and on blowing the nose, two patches of light appear in front of the eye. Even when we turn the eyeballs quickly, the retina is pressed at the points of muscular attachment, two circles or semicircles being seen towards the nose.

When we consider the variety of forms which in perfect health the imagination can conjure up when looking into a fire, we may readily conceive how the masses of colored light which float or remain stationary before the eye may be moulded into those fantastic or natural shapes which haunt the couch of the invalid, even when the mind retains its energy, and is conscious of the illusion. A sailor who had strengthened a thin sail by brushing a part of it with tar, saw upon it, when hoisted up, a gallows and a man under it without a head. He pointed it out to his shipmates as indicating that something would happen. The picture was so strongly delineated that he could not bear the sight of it, and as soon as the sail was taken down, he covered the figure with a piece of canvas. His anticipation was verified. He was himself executed for piracy and murder. When we look at a luminous point it remains visible and of the same color for nearly the eighth of a second after the eye is shut. This effect will be seen in the circle of red light produced by whirling round a burning stick in the dark, and in the moving cars it is finely displayed in the visibility of objects eclipsed by a hedge or paling with broad vertical bars separated by narrow openings. The light which passes from objects through one narrow opening continues to impress the retina till the light from the next opening renews it, so that the hedge and the palings are actually so transparent as to allow us to see objects behind them, which if in a state of rest would be absolutely invisible. This duration of impressions on the retina is the principle upon which the pretty toy called the thaumatrope, or wonder turner is constructed. A cage, for example, is drawn on one side of a circular disk of cardboard and a bird on the other. By twirling the disk with a string fixed to its circumference, the bird will be seen in the cage, the picture of the cage remaining impressed upon the retina till the picture of the bird comes round, and is seen at the same time. The magic disk is constructed on the same principle, by the rotation of which the picture of animals are made to appear in motion, and the pictures of machinery to be actually working. When we look long at any ordinary luminous object and turn the eye away from it upon a white ground, we see for a short time a distinct picture of it, but of a different color. If

the object looked at was red, the one on the white wall will be green and of the same shape, the color on the white ground being the complement of the original object.

Another curious condition is that produced by certain diseased conditions of the optic nerve, which has been called half vision, where only one-half of an object can be seen, such as the half of a man whom we meet, or half of the name on a signboard. When this half vision is complete it may produce effects approaching to the supernatural. At certain distances, one of two or more persons will disappear, and reappear by a slight change of position, either of the observer or the observed. When only one person is in view, he may disappear altogether, under circumstances which would be inexplicable to the observer. One of the most remarkable illusions to which we are exposed, arises from the use of the eyes in combining the pictures of objects formed on their retinæ. Let us suppose that the wall paper of the room consists of flowers placed at the distance of twelve inches apart, which we can unite by squinting, or converging the optic axis to a point between ourselves and the wall. If we unite the flowers twelve inches apart when standing three feet from the wall, all the flowers on the wall will be united, each flower consisting of two, superimposed, and appearing at the point to which the eyes converge. The whole papered wall with all its flowers, in place of being seen, as in ordinary vision, at the distance of three feet will now appear suspended in the air, at the distance of six inches from the observer. From this we may learn not to be alarmed at the ghosts of wall paper hangings. When this phenomena occurs after dinner, the observer should take the pledge of total abstinence. Ladies should be careful to avoid large or geometrical patterns for their clothing, as the observer can hardly avoid uniting squares or other analogous figures in female dresses, thus causing part of the dress to bulge out or sink in hollows, a result which, while it gives pain to the eye of the observer, does not improve the person observed.

GENERAL DESCRIPTION OF THE EYE.

Most of my hearers are probably aware that the eye of the most highly organized animals and of man is a camera obscura, or dark chamber, similar in many respects to the instrument with which the photographer accomplishes his very beautiful process of making pictures by the power of light. The analogy of the camera to the human eye is, however, not complete in all particulars. It fails in one very important point. The camera is adapted to its picture-forming work by sliding the front part of the frame in or out, according as the objects to be depicted are far or near. In the telescope exactly the same adjustment for varying distance has to be performed by the sliding in or out of the tube containing the magnifying glass. Although the human eye is modelled upon the same general principles as the camera obscura, the

resemblance has not been carried so far as to confer upon it any form of sliding adjustment, nevertheless it does possess some means of accomplishing an adaptation to distance.

Most persons are aware that they can, at will, look either upon trees or hills, upon the remote horizon, or on the letters of a book held at arm's length, and see both with equal facility and clearness. But we cannot see both objects at the same time. To demonstrate this, take a piece of net and hold it between a printed page and the eye, either the printed page or the fibres of the net can be seen at will; but they can only be seen one after the other. When the letters are looked at, the net only presents itself in a shadowy and ill-defined fibre, and when the net is the object of attention the letters melt away into a field of gray haze. In order to see first one and then the other, some change has to be made in the arrangement of the structure of the eye, and if the net is held very near to the eye and looked at fixedly for some time, the effect is quite palpable, for it is soon accompanied by a sense of fatigue. Before this matter of accommodation can be grasped, however, a brief reference must be made to the structure, conditions and arrangements upon which it depends. The outer investment of the eyeball consists of a tough white membrane of much strength, which is termed the sclerotic coat. It is opaque and impervious to light, except for a short space in front, where it is transformed into a kind of bow window of transparent horn-like substance called the cornea. Through this window the pupil and iris can be seen. The iris is an adjustable curtain of interlaced muscular fibres arranged immediately behind the cornea in such a way that it can be more or less drawn according to the need of diminishing or increasing the admission of light. The pupil is simply a hole in this muscular curtain. Immediately behind this opening, called the pupil, is fixed a double convex lens of transparent crystal, having the power to form a picture behind its posterior curved surface, in the same manner as the lens in the photographer's camera. The picture formed by the lens in the eye may be actually exhibited in the case of a white rabbit, the coats of whose eyes are deficient in the usual opacity of the external coverings of the organ. When such an eye, removed recently from the animal, is held up with the pupil and cornea directed toward the flame of a candle or toward a landscape, an inverted image of the flame or landscape will be seen on the back part of the globe. In the living eye the image of light thus formed by the instrumentality of the lens falls upon the nervous expansion, which is termed the retina, and through the agency of its connection with the brain is capable of feeling the image in all its diversity of color and luminous intensity. Such in barest outline are the mechanism and the optical arrangements upon which the function of vision depends. The eye is preserved in the convenient form of a sphere by the simple device of having its interior filled with liquid, which prevents the otherwise flexible coats from puckering up

into an irregular shape. In the eye there are two quite distinct chambers in which the liquid is distributed, one in front of and the other behind the crystalline lens. The liquid in front is called the aqueous humor, and is little more than a solution of salt; the portion behind more nearly resembles the white of egg, and resembles somewhat glass, and is therefore called the vitreous humor. In order to look at near and far objects with equal distinctness, the lens is converted into a more powerful instrument of refraction. When near objects are looked at by a drawing in of its transverse dimensions and a bulging out of its front contour; or, in other words, a change in the shape of the lens without any variation in its bulk. The act of accommodation is produced by the action of a muscle which entirely encircles the lens and by its contraction and relaxation causes the lens to be made more or less thick, so that without any sliding apparatus in the eye we have accomplished by means of this muscle a perfect arrangement. The amount of accommodation for near vision is proportional to the quantity of muscular energy that is called into play. It is the loss of this power that causes old sightedness, this being the first muscle in the body to give out.

The optic nerve which enters the back part of the eye, about $\frac{1}{10}$ of an inch to the inner side of the centre, is a thick white cord $\frac{1}{6}$ of an inch in diameter. It is the great channel of visual impressions from the eye to the brain, where it has its origin. It is composed of very fine nerve threads packed close together; there are at least 250,000 of these in each optic nerve. When this thick white cord has passed through the coats of the eye, it spreads out into a fine delicate membrane called the retina, which is the screen on which the images of objects are formed. This delicate membrane is about $\frac{1}{200}$ of an inch in thickness, and at one point opposite the centre of vision is more delicate than the rest and is the most acute point of vision. The further the image is formed on the retina from this part, the more blurred does it become. In reading we have all noticed how the eyes move across the page in order to take in the line, as we are not able to read the whole line at once. But as there is one spot of supreme sensibility in the eye, there is also another part of the retina which is absolutely insensible to light, this is known as the "blind spot."

Although rarely noticed it is easily discovered when the attention is drawn to its existence. If a cross be made on a sheet of paper, and a circle three inches and a little lower away to the right, the left eye closed and the attention of the right eye steadily fixed upon the cross, the paper being held at ten or twelve inches distant, both will be distinctly seen. Now move the paper slowly towards the eyes, which must be kept steadily fixed upon the cross; at a certain point the circle will disappear, but as the paper is drawn closer it will reappear. The explanation of this insensible spot is that it occurs when the optic nerve enters the ball

of the eye, and where therefore there are no terminations of nerve threads for the perception of the visual impression. The blind spot was detected by the French priest Marriotte during the reign of Charles II. Marriotte was in the habit of amusing the king and his courtiers by showing them one-eyed apparitions of themselves with their heads cut off.

The crystalline lens which plays the chief part in forming the beautiful image that is traced on the retina, is itself constructed of a series of flattened fibres grouped in loops and packed together like the layers of an onion. The transparent mass built up is comparatively soft at the beginning of life, but gets harder and dense as times goes on. As we get older the lens becomes more firm and hard, and the muscular action of accommodation cannot be carried on as well. The adaptation of sight for distance requiring no muscular effort remains the same. But the bulging out of the lens for dealing with near objects can not be performed. At the age of forty years the lens cannot generally be curved enough to form a sharp image of any object that is less than nine inches away. The remedy for the failing and imperfect sight of age is to add such a second lens in front of the eyes. In other words, spectacles with convex lenses must be employed when the sight is used for near objects. The increased refractive power which cannot be furnished by the act of accommodation is then artificially supplied by the addition of an outside lens. One of the first signs of old sightedness is the pushing of the book further and further away until the arm becomes too short, then the patient seeks glasses.

No more mischievous mistake can well be made than the one which is involved in the prevalent idea that the use of spectacles should be put off as long as possible. On the contrary, the longer they are put off the more harm is done to the eye, as the delicate mechanism of the eye is strained.

(The common prejudice against using spectacles as the impairment of sight begins to be observed with advancing age appears to have unfortunately arisen from the fact that this condition has been confounded with a diseased condition known as glaucoma, where the patient not properly treated become hopelessly blind, and from this it has been argued, by those not knowing, that the glasses were the cause of the blindness.) In all persons of forty years or upward, having blurring of near objects in either reading or sewing, especially at night, should have proper glasses selected by a competent person, and use them for all near work. We have also a condition of the eye where the globe is too short, and such people are termed far-sighted or hypermetropic; this occurs in early life and is in reality a deformity. This condition requires a convex lens for its correction, and when properly selected gives great relief to the patient. The defect known as short sight is due to the eye-

ball being too long or the lens in the eye being too thick, so that the focus is formed in the eye before it should, and an indistinct image of the object is formed on the retina. Short-sighted persons can see very near objects sharply, but any object twelve inches away is dull and obscure; they can also see with much fainter light. The remedy in the case of the short-sighted eye is the employment of spectacles with concave lenses; by the use of the lenses the rays of light that enter the eye are made more divergent than they otherwise would be, the focus is thrown back on the eye, so that it reaches the retina at its proper place.

Short-sighted persons begin the use of the spectacles as soon as the defect of vision is discovered. It is often an hereditary defect, yet may become acquired from close reading or other near work. It ought to be more generally understood that the short-sighted eye is at all times to be looked upon as a weak organ, and as open to dangers that do not affect the normal eye. Many delicate children sow the seeds of near-sightedness in school by straining at close work.

Careful investigations made both in Europe and in this country prove that something like one child in every ten in ordinary schools is affected with short-sight, and that these are almost invariably found in badly lighted schools, and where the desks and seats are so planned as to cause stooping while at work. It has also been shown that the near-sightedness increases in the same individual as his studies become more arduous and complicated.

Forty years ago attention was called to the fact that numbers of the students in German high schools wore spectacles. In 1861 the first systematic examinations were begun; since then many examinations have been made, and in more than 40,000 scholars investigated, the following results are shown:

In village schools hardly 1 per cent.

Elementary schools.....	5	11 per cent.
In the girls' schools.....	10	24 "
In the real schools.....	20	40 "
In the high schools.....	30	55 "
In the colleges.....	52	64 "

In other words, a student, near-sighted when in the lowest school, gradually increases his difficulty by continuous study, and finishes his studies with worse eyes than when he began.

As regards the nationality on the development of the affection, we find as follows, in the same grade of school:

Germans.....	45	per cent.
Americans.....	38	"
Swedes.....	37	"
Russians.....	31	"
Bostonians.....	28	"
New York.....	27	"
French.....	22	"

In New York, in 1876, it was found that myopia existed in—

Germans.....	24	per cent.
Americans.....	20	“
Irish.....	14	“

School-books should be so printed so that no letter should be less than one-seventeenth of an inch high ; the space between the lines should be at least one-eighth of an inch ; and the length of the line should be three and one-half inches.

School desks and seats are usually faulty, as follows :

1. They do not correspond to the size of the pupils.
2. The feet are unsupported.
3. The book is brought too near the face.
4. The seat is too far from the desk, causing stooping in writing.
5. Desk-tops flat, instead of inclined.

Light should be plenty and diffused, and if possible should be from above.

There is another form of irregularity of vision, dependent on faulty construction of the optical mechanism of the eye, which is frequently met with, and is due to the curvature of the front portion of the eyeball being different from the other meridians of the globe. The curve is for the most part flatter in the transverse direction than it is in the vertical one ; when the letters in a printed book, which are principally composed of upright strokes, are so confused that they cannot be distinguished from each other. To this condition the name astigmatism is given. This error of vision is apt to produce severe headaches, and the most persistent treatment by medicines will avail nothing, when the proper glass ordered by one expert in such matters will make the vision marvelously improved and the headaches entirely disappear. This defect is capable of being remedied by a lens of a cylindrical curvature which differs very much from those ordinarily worn. There is one very serious defect of the eye too frequently met with, which has an interest of its own on account of the success with which the principles of optical science are applied for its relief. It often happens that the lens in the eye hardens with advancing years, that it thickens at the same time and loses its natural transparency, so that the light only can pass through and no definite objects can be seen. The remedy for this is the removal of the lens, or cataract, as this opacity is called, and the employment in its stead of an artificial lens of glass placed in front of the eye. The crystalline lens is extracted from the interior of the eyeball through an opening cut in the outer coat of the eye. After the removal of the lens or cataract, no distinct image is formed on the retina, or back part of the eye, so that a convex lens of strong power to take its place must be

put in spectacles and worn in front of the operated eye. Spectacles of different powers have to be employed for near and distant objects, as the accommodation of the eye is destroyed by the operation.

Although we have seen that the image of objects was formed on the retina, we have to go still further in order to get the mental impression of the image. After the retinal image is formed, the nerve-influence passes from the eye to the brain at the sluggish rate of two hundred feet in the second, whereas the vibrations of light which strike the eye pass in the same brief interval nearly two hundred thousand miles. That the brain-perception of an image is altogether a different affair from the mere stamping of a luminous impression upon a sensitive screen is further proved by several considerations in no way explained by physical agency. There are two eyes employed in the process of vision, and the pictures are formed upon the nerve-structures. But only one image is seen, unless the motion of the two eyes is deranged. There is an inseparable fusion into one mental impression or perception. This result requires that each of the images shall fall upon a corresponding part of the associated eyes. With squinting eyes this condition is deranged, and two images are seen. You will remember that the image formed in the eye is inverted (as seen by the experiment with the eye of a rabbit), yet the simple image seen in the ordinary operation of sight is upright. Many themes are advanced to explain these curious things, but they are all unsatisfactory. We learn to see as we learn to speak. As in telegraphy, the clerk proceeds to telegraph to somebody at the other station, the man at the other station does not hear words, but sees the signs of words—needles moving in a way arranged to stand for certain words. Just in the same way there is the actual picture produced at the back of the eye, but in the ganglion it is not a picture, but a series of signs. Now, this is the important point: our sensation of sight corresponds, not to the picture which is at the back of the eye, and which fairly represents the external object, but it corresponds either to this excitement in the ganglion or to an excitement farther back still—we do not know which, but the only thing quite certain is that our sensation of seeing a thing does not correspond to the picture made upon the retina, but to something which is the mere sign of that picture. Vision is the work of prolonged and complicated experience, which begins in the cradle and only ends on the margin of the grave. Much has been written as to whether we see distance. The distance of objects we look at is inferred from the muscular effort which is made in increasing the curvature of the lens and in converging the two eyes on the point of attention. The idea of rotundity and of projection results from the consideration of the difference of aspect incident to varying points of view.

Many years ago an ingenious tale appeared in one of the English journals, the hero of which had a theory to the effect that the last object seen by a dying person was imprinted on the retina, and could by suit-

able means be photographed and preserved. His description and success were detailed with great appearance of truth, and in the end he discovered the murderer of his sister by recognizing a chance-met stranger, the original of the portrait he had years before obtained from the eye of the victim. It is curious how prophetic the seemingly wild fable has turned out as a wonderful discovery. Not long ago a German observer noticed that a beautiful purple color was produced in the eyes of frogs; he further noticed that the purple color was invariably bleached and destroyed upon exposure to strong light, and that it could be reproduced out of the original cells when the eye was left for some time in the dark. This has been called the "visual purple." Another German observer has, however, succeeded in fixing the image stamped luminously upon the retina of a dead eye by washing the membrane, after exposure to light, with a solution of alum. This gave rise to the idea that vision may possibly be a photographic process. That such is not the case, however, is manifest from the fact that the visual purple is absent from the most acute point of vision. These discoveries are very curious, and deserving of further investigation. This is a great stride in bringing the mysterious processes of life within the grasp of ordinary chemico-physical laws. Much yet remains to be done, the realm of things unsettled is still but an

"Isle of bliss

'Mid most the beating of a steely sea."

Of late years much has been written of that strange defect, viz., color-blindness. In some persons the retina appears to be affected in one and the same way by rays of light of various colors, or even all colors. Such color-blind persons are unable to distinguish between the leaves of a cherry-tree and its fruit by the color of the two, and see no difference between blue and yellow cloth. This peculiarity, which is simply unfortunate for most persons, may be dangerous if unknowingly possessed by railroad engineers or sailors; it may arise from a defect in the retina which renders it unable to respond to different kinds of luminous vibrations, or it may proceed from some unusual absorptive power of the humors of the eye. About one in every twenty-five men are color-blind, and one in every thousand females. The great difference is supposed to be due to the prevalence of color in female dress, and the great use women make of such bright objects, and that thus having to do with colors for generations has caused a better development in the female perception. Many railway accidents have been supposed to be due to the mistaking of the signals by a color-blind engineer. The defect is congenital, and cannot be cured by glasses or medicine.

If the little organ of which we have been speaking is so wonderful and far-seeing in its normal state, and is the source of so much pleasure,

how must the unfortunate who are bereft of their vision feel in their blank world of darkness ! That sight is the most valuable of the senses, the most important inlet of knowledge, the most valuable medium of communication with surrounding persons and objects, and that it is also essential to the full enjoyment of our other senses, every one feels.

Loss of sight is the greatest misfortune even to the rich, who can alleviate it by purchasing the aid and services of others. How much more severely must it be felt by the poor, who, being rendered incapable of labor and having their minds uncultivated, find their existence reduced to a dreary blank ! Even the great poet repeatedly reverts to his blindness, and always in a tone of anguish, and says :

“ Thus with the year
Seasons return ; but not to me returns
Day, or the sweet approach of eve or morn,
Or sight of vernal bloom, or summer’s rose,
Or flocks, or herds, or human face divine ;
But cloud instead, and ever during dark
Surround me, from the cheerful ways of men
Cut off, and for the book of knowledge fair
Presented with a universal blank
Of nature’s works, to me expunged and rased
And wisdom at one entrance quite shut off.”

It is unfortunate that Milton should have been one of the unhappy blind, for as a rule they, the blind, are happy, contented, and cheerful. Milton’s eminence as a poet and scholar makes his example conspicuous, and his words to be taken as the natural language of a class of unfortunates. There have been others more admirable in this respect, for they set forth in their lives and conversation the sublime moral height to which men may attain by grasping courageously the nettle misfortune and “plucking thence the flower of happiness.” The blind as a class are limited to such narrow spheres that those unacquainted with the subject fail to realize how large a proportion of the human race are deprived of sight. In the temperate regions about one in every thousand of the population are blind, but in less favorable climates the percentage is much greater. The number of deaths among the blind is from sixty to eighty per cent. greater than in those having good vision. It behooves us, therefore, to so make use of our eyes that we may escape the various diseases and ailments which affect it, and go through life—which at best is too short—seeing all the beautiful things nature has surrounded us with. For undoubtedly the human eye is more abused than any organ in the body, and it is only by telling the people of the dangers, that we will finally overcome them. Who of my hearers would think of walking all day and then continuing the same all night ? Yet many of you are doing the same thing, practically, when you use your eyes in business all

day, under poor illumination, and then in the evening sit up till the wee small hours reading some poorly printed novel. The eye, as well as the other organs in the system, needs rest. Always read with good illumination, and, above all things, never read lying in bed. Another very grave evil is the habit of selecting glasses haphazard and buying the cheapest possible ones. This is all wrong. (Some will say the speaker is interested in this matter; so I am, yet not in any mercenary sense, but for the good of the individual.) Those who purchase fifty-cent glasses sooner or later have trouble, for in the matter of glasses it is the same as in everything else: to get a good article, a fair price must be paid.

If with these few plain truths and fragments of scientific knowledge, hastily thrown together, in the midst of a busy life, I have imparted any new idea or any train of thought in my hearers' minds, I shall feel well repaid.

“To man's short reach of mind, and scanty powers,
How much is dubious in the things he sees,
How much eludes his sight.”

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